Aircraft-Borne Meteorological Measurement Systems

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The aircraft-borne Meteorological Measurement System (MMS) provides high-resolution meteorological parameters (pressure, temperature, and the three-dimensional wind vector). The MMS consists of three major systems: (1) an air-motion sensing system to measure the velocity of the air with respect to the aircraft, (2) an aircraft motion-sensing system to measure the velocity of the aircraft with respect to Earth, and (3) a data-acquisition system to sample, process, and record the measured quantities. Because much of the instrumentation is attached to the aircraft at carefully chosen locations, the MMS is a platform-specific instrument and cannot be moved from one aircraft to another.

The MMS is uniquely qualified for investigation of atmospheric mesoscale (gravity and mountain lee waves) and microscale (turbulence) phenomena. An accurate characterization of the turbulence phenomenon is important for the understanding of dynamic processes in the atmosphere, such as the behavior of buoyant plumes within cirrus clouds, diffusions of chemical species within the wake vortices that are generated by jet aircraft, and microphysical processes in breaking gravity waves. Accurate temperature and pressure data are needed to evaluate chemical reaction rates, as well as to determine accurate mixing ratios. Accurate wind-field data establish a detailed relationship with the various constituents and the measured wind also verifies numerical models used to evaluate air-mass origin. Because the MMS provides quality information on atmospheric state variables, MMS data have been extensively used by many investigators to process and interpret the in situ experiments aboard the same aircraft.

Over the past decade, the MMS on board the ER-2 aircraft has successfully participated in major NASA field missions: STEP in 1987, AAOE in 1987, AASE I in 1989, AASE II in 1991–1992, SPADE in 1992–1993, ASHOE/MAESA in 1994, and STRAT in 1995–1996. In 1997, the ER-2 MMS completed a series of three campaigns of the POLARIS (Photochemistry of Ozone Loss in the Arctic Region in Summer) mission. The campaigns were based in Fairbanks, Alaska, and in Barbers Point, Hawaii.

The MMS on board the DC-8 aircraft has successfully participated in two major field campaigns: the Subsonic Aircraft: Contrail and Cloud Effects Special Study in 1996, and the SONEX (Subsonic Assessment Ozone Nitrogen Oxide Experiment) in 1997. SONEX concentrated in the North Atlantic flight corridor to study the effect of airline traffic on the atmosphere.

New software was developed for both platforms in order to automate the operation of the dedicated laser gyro Embedded GPS Inertial Reference System (GPS is the Global Positioning System). The fundamental pressure measurements were also improved with active thermal controls, thus improving final meteorological data.

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